THE PHYSIOGRAPHIC FEATURES OF THE KLAMATH MOUNTAINS.

CONTENTS.

INTRODUCTION.

THE Klamath Mountains were first recognized as a group deserving to be distinguished from other Coast Ranges and the Sierra Nevada when C. E. Dutton and J. S. Diller began their reconnaissance work in northern California and southern Oregon. It was first outlined in 1886 by Captain Dutton[1] as including all the mountains lying to the west of the upper Sacramento and Rogue River valleys, and probably other mountains of a similar age joining them on the north and south. The group was more definitely defined and characterized by Mr. Diller in 1892–93,[2] and their limits were extended southward beyond the fortieth parallel and northward to include the Rogue River Mountains, and some of the mountains of the upper Umpqua basin. According to Mr. Diller the name was first proposed by Major Powell many years earlier.

Geologically, the group of ranges now known as the Klamath Mountains resembles the Sierra Nevada in age and in the character of their formations, both igneous and sedimentary, though but little has yet been done to show their geological features,

[1] *Seventh Ann. Rept. U. S. Geol. Surv.*, pp. 97–103.

[2] *Fourteenth Ann. Rept. U. S. Geol. Surv.*, Pt. II, pp. 403–34.

except in their broader outlines. They embrace both sedimentary and igneous rocks, ranging in age from the Paleozoic to the Tertiary, though the later rocks form only a small portion of their mass and occur only in the larger valleys of the region. This group of mountains, which is clearly separated from the Sierra Nevada by the broad structural valley of the Sacramento, has been distinguished from the Coast Ranges to the north and south mainly upon geological hypotheses, it having been supposed that the ranges on either hand were of more recent origin, involving essentially younger strata. It yet remains to be shown, however, whether a satisfactory boundary can be so established, particularly upon the south. The metamorphic rocks of the Klamath system, including its schists and limestones, appear to be represented along the coast at intervals even as far south as San Francisco or even farther. The slates, cherts, and limestones of the Franciscan series, moreover, have their representatives among the Klamath Mountains and throughout the Coast Ranges.

GENERAL FEATURES.

The chief ranges.—The mountains included in the Klamath group have generally been regarded and described as a physiographic *complex*—a group of mountains without any definite order or relation, occupying a position at the junction of all the other systems in this portion of the coast. It is the purpose of this paper to call attention to a few of the more prominent facts pertaining to this question and to point out if possible some general system in their arrangement that has heretofore escaped notice. While it cannot be denied that the group holds in the main the position above described, it is believed that their disorder has been largely imagined. On the whole the group embraces a number of more or less independent ranges, some of which are much more prominent than others, some of them not having yet been distinguished by recognized names. They may be readily classed into two main systems which are believed to have a definite relation to the dynamical history of

the region, probably representing two or more periods of revolution.

The two systems of ranges cross each other nearly at right angles. The most conspicuous ranges, among which are the Rogue River, Siskiyou, Scott, and Trinity mountains, have a westerly, or south of westerly trend, while the Yallo Bally, Bally Choop, South Fork, and Salmon River Mountains, and many of the less important spurs and ridges approximate a more northerly or northwesterly course. The fold represented in the Salmon River range particularly can be followed from the Trinity basin nearly continuously northward to the Rogue River Mountains, crossing perhaps all of the ranges running toward the coast. Of the east and west ranges it should be noticed that while all of them apparently terminate in the vicinity of the Cascades, this termination, for two of them at least, is more apparent than real. The east and west axis, for example, that is represented by the Rogue River Mountains crosses the Cascade range near Mount Thielsen and continues in a north of easterly direction through eastern Oregon toward the equally old cluster of the Blue Mountains, and forms a broad though high divide between the drainage of the Klamath Lakes and the Deschutes and Crooked rivers, flowing toward the Columbia.

In a similar manner the high range traversing northern California in almost a parallel direction, along the southern border of Siskiyou county, has an eastern projection which crosses the Cascades in the vicinity of Mt. Shasta and forms a high divide which separates the drainage of the Klamath Lakes and river from that of Pitt River and the Sacramento. Midway between these two folds is the Siskiyou range, almost parallel to the others, but not traceable beyond the Cascades. On either side of the Siskiyou range are the valleys of Rogue River and the Klamath. Each of the three ranges contains old crystalline rocks, including granites, gabbros, and peridotites, whose age undoubtedly antedates the later Cretaceous rocks to be described presently. While it is not clear that these crystalline elements have any direct bearing upon the question, it cannot be denied

that these ranges represent axes of structural development that are very old compared to others that may be described.

Notwithstanding the fact that they have an east and west course, that has had a controlling influence upon the greater drainage, still it is not difficult to also recognize the north and south lines of folding traversing the country. South and west of the Trinity River the northwesterly direction of folding is shown by the course of all the larger streams. But even in the more central and most confused section of the Klamath group, that lying between the drainage basins of Rogue River and the Trinity, the north and south trend of the ranges impresses itself upon an observer, and the crossing of the ranges forms a magnificent spectacle for one who appreciates the larger features of mountain topography—and the influence of the factors controlling them is carried even into the smaller structural details of the country, regulating even the course of many smaller streams as well as that of dikes and auriferous veins.

Evidences of a peneplain.—Possibly to these facts is due in a measure the appearance in many portions of the group of a great uplift and dissected plain. Standing on any of the higher elevations of the country, say at an altitude of about five thousand feet, and looking over the surrounding mountains, one is often struck by the comparative uniformity of their outlines against the sky. From four to five thousand feet is for the most part their greatest altitude, and there are long ranges and ridges that stretch for miles at nearly a uniform level within these limits. One of the best examples of this fact is the South Fork range on the western boundary of Trinity county, which makes an even sky line for forty miles or more at an altitude above five thousand feet. The Siskiyous, the Yallo Bally, and Bally Choop ranges all furnish good examples of the same character. The general effect of this uniformity of level is that already suggested as a great uplifted and dissected peneplain that has been warped and diversified by differential movements subsequent to its development. South of the latitude of Cape Mendicino, Dr. Lawson has stated,[1] there is a broad peneplain that rises from a

[1] *Bull. Geol. Depart. Univ. Cal.*, Vol. I, pp. 242–44.

general elevation of 1,600 feet along the coast gradually toward the interior. Its eastern margin may be seen from the Sacramento valley, and, as viewed from the railroad, it has somewhat the effect of an escarpment that gradually rises toward the north. If the level effects of the mountains north of the Trinity basin are properly regarded as a peneplain, it is in a sense the northward continuation of the one described by Professor Lawson, and which rises gradually toward the north as well as toward the east. This approach to a peneplaination has been recognized by Mr. Diller,[1] and correlated with that represented in the

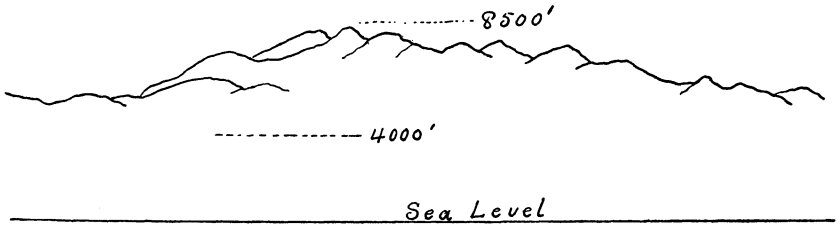

FIG. 1.—Profile view of the great Salmon mountain fold, south of the Klamath River.

broad western slope of the Sierra Nevada, which has been described as an inclined baselevel, the deformation of which took place at a comparatively late epoch. The great north and south fold already referred to rises above this level to an altitude generally of seven or eight thousand feet, as in like manner do also the Siskiyou, the Scott, and the New River ranges. The peneplain is distinctly noticeable along the coast in northern Humboldt and Del Norte counties, passing into Oregon, where it generally has an altitude between two thousand five hundred and four thousand feet.

The valley depressions.—All the larger valleys of the Klamath Mountain region are structural valleys. For the most part they may be included in two or three systems or basins, the significance of which has not yet been sufficiently recognized. One of these systems describes a broad curve across the northern portion of the Klamath Mountains, the other crosses them at the south.

[1] *Eighth Ann. Rept. U. S. Geol. Surv.*

As will be shown later, Shasta and Rogue River valleys are easily united, while the latter may be followed westward, toward and into a somewhat close connection with the valley of the Illinois River. On the other hand, the valleys of the Trinity basin may be linked together, connecting on the east with the valley of the Sacramento through a low divide between important ranges. Looking westward from the Sacramento valley in the neighborhood of Red Bluff one sees a low depression, separating what otherwise appears to be a continuous range of mountains bordering the Great Valley along the west. This depression is a low divide leading into the Trinity basin between the Yallo Bally and Bally Choop ranges. Beginning at this point a broadly curved line may be drawn in a northwesterly direction down the valley of a southern tributary of the Trinity, including the Hay Fork, Hyampom, South Fork, and Hoopa valleys, and extending to the mouth of the Klamath River. A little farther to the north a similar line may be drawn along the course of the main Trinity River, which merges into the former at the junction of the South Fork and the main branch of the Trinity. The two are included in what is here called the Trinity basin, which probably should be regarded as the southern limit of the Klamath Mountains, unless a purely geological or lithological basis of definition is to be employed, in which case they should be extended southward nearly, if not quite, to the Bay of San Francisco.

Type of valleys.—A peculiarity of all the intermontane valleys of the Klamath system is the manner of their drainage. Almost without exception their outlets cross one or more ranges through a narrow gorge or canyon. Shasta valley, for example, lying on the eastern flank of the older mountains, is drained, in common with the valley of the Klamath Lakes, by the Klamath River, which traverses a broad stretch of mountainous country to the westward for nearly one hundred miles before it emerges into the broader valley near its mouth. In its course it crosses the axis of the Salmon River range and other smaller ranges, through which its valley is reduced to the character of a gorge. And these valley-basins sometimes contrast rather

strongly with their drainage canyons. Scott valley, for example, lying entirely within the limits of the Klamath Mountains, has a nearly level bottom with general dimensions of eight by twenty-five miles, into which converges the drainage of more than twenty miles radius, yet the outflow from this valley goes through a canyon more than twenty miles in length, which is almost impracticable for a wagon road to follow. Indeed, in some places the walls of the canyon rise precipitously for more than a thousand feet. Most of the interior valleys are of this type, including the valley of the Hay Fork, Hyampom, Trinity, and Hoopa valleys, the Salmon River, the Illinois, and others.

Deductions.—The explanation of this interesting fact is that already suggested in a former paragraph. It is evidently a result of the cross-folding of the country—that is, to the development of folds transverse to the course of a drainage that had already been established. It is not maintained that this north and south system is entirely younger than the drainage, for this is not true, but it appears to be evident that there has been an uplifting of these transverse ranges after the drainage of the region had become established. The progress of this movement was not more rapid than the erosion of the streams in a downward and opposite direction. The transverse barriers are mainly north and south, or, to be more exact, a few degrees to the west of north.

These observations apply equally to the Trinity River, the Salmon River, the Klamath, and Rogue River, and, as has been said, to Scott River, the Illinois, and to some of their smaller tributaries.

THE LARGER BASINS.

The larger basins already outlined probably had their origin in the midst of, or prior to, the Cretaceous period. The Rogue River basin, while it does not topographically include the valley of Shasta River, yet in a geological sense it includes not only this, but also the valley of the Klamath Lakes as well. The Trinity basin has been already shown to extend from the upper Sacramento and to include the larger valleys tributary to the

Trinity River. Between these basins lies that of the Klamath and Salmon River drainage, the history of which has been only in part parallel to the others. The history of these basins can be best known from a study of their later sedimentary deposits.

THE LATER SEDIMENTARY DEPOSITS.

The later sedimentary deposits of these basins include only those of later Cretaceous and of Neocene ages.

The Chico deposits.—The Cretaceous deposits are largely those of the Chico, and consist of shales, sandstones and conglomerates, the lighter materials generally forming the lower portions of the series. As a rule they are fairly fossiliferous, and often extremely so. In their distribution the Cretaceous deposits occupy both of the basins above described, which appear to have been distinct and separate inlets from the sea. Although it has been the opinion of Mr. Diller[1] and others, including the writer, that the Cretaceous deposits of southern Oregon and the upper Sacramento valley have had a connection through what has been called "the Lassen Peak straits," the proof of such a connection has not yet been satisfactorily shown, and there is evidence in favor of a different conclusion. Mr. Diller himself has expressed a conviction[2] that many of the topographic features of the Klamath mountains have remained only partially modified since Cretaceous time. In this connection it is worth while remembering that the granitic and basic crystalline rocks of the Klamath Mountains are the counterparts of those in the Sierra Nevadas, but in the latter range they are generally conceded to have antedated the later Cretaceous. An axis of such rocks certainly extends eastward beyond Mount Shasta, and the probability is that the high divide between the drainage basins of the Pitt and Klamath rivers is of pre-Chico age, even including some of the older lava flows of Mount Shasta and the range to the eastward. This is rendered especially probable by the fact that the Chico beds almost on the western slope of Mount Shasta contain bowlders and pebbles

[1] *Eighth Ann. Rept. U. S. Geol. Surv.*, pp. 411–13.

[2] *Bull. Geol. Soc. Am.*, Vol. V.

of andesitic lava that could hardly have come from any other source. But one of the strongest evidences of disconnected basins during the later Cretaceous is found in a comparative study of the Chico faunas of southern Oregon and the Sacramento valley. The dissimilarity of these basins has been partially brought out by the writer in a former paper on the "Cretaceous Deposits of the Pacific Coast."[1]

The Cretaceous basin of southern Oregon represented in the deposits of Rogue River valley extended therefore southward to the foot of Mount Shasta and eastward, as shown by fossiliferous deposits, into the basin of the Klamath Lakes, and was perhaps bounded along the north, at least in part, by the older mountains of the Rogue River range. This basin connected with the ocean along the present course of Rogue River valley. In the basin of the Trinity River the later Cretaceous deposits occur, but whether the outlet of the basin was toward the Sacramento, or westward toward the ocean, has not yet been determined. But the Cretaceous deposits (probably the Chico) have a considerable distribution along the different tributaries of the Trinity, and the outlet may have been in both directions. Chico deposits have been found as far west as the Hay Fork valley, or even on some of the tributaries of the South Fork at an altitude that might easily connect them with the Pacific. Eighteen miles southwest of Hay Fork these deposits occur at an elevation of three thousand feet above sea level.

The Eocene period left no deposits in the Klamath Mountains, as restricted, that have yet been recognized, nor have they been discovered anywhere in the region between the Marysville Buttes and the valley of the Umpqua River. Throughout these basins, wherever the Neocene deposits occur, they rest nearly conformably on the Chico, or on the older basement rocks. The conformity of these beds upon the Chico is so marked that it is often difficult to distinguish them.

The Neocene deposits.— The Neocene deposits of these basins consist very largely of non-marine sediments, often plant bear-

[1] *Proc. Cal. Acad. Sci.*, 3d ser., Vol. II.

ing, and containing evidence of volcanic activity. Two members have been generally recognized, the Ione formation, and the Tuscan tuff. Mr. Diller states that the Ione formation on Little Cow Creek, Shasta county, has a thickness of five hundred feet and that to the east of this there is a great thickness of clays, sands and gravel which are sufficiently indurated to be called shales, sandstones, and conglomerates, and which he calls Ione. The lower half of the Ione formation on Little Cow Creek is composed chiefly of sandstones and shales, with a bed of coal and carbonaceous material twelve feet thick, with an abundance of fossil leaves.

In the basin of Shasta valley similar beds occur with plants and carbonaceous layers, and entirely similar deposits occur along the western slope of the Cascades in the Rogue River valley. These beds are best exposed a few miles to the east and to the north of Ashland, Ore. Four miles north of Ashland, where the series has been well exposed by faulting. they have a thickness of about three hundred feet. Similar deposits occur also throughout the Trinity basin, as at Weaverville, Big Bar, Hay Fork, and Hyampom. In the Hyampom valley, in western Trinity county, these beds are well exposed, and contain layers of coal and carbonaceous matter, and the leaves of many Neocene plants, including the Sequoia.

Lake systems of the Neocene.—As in the Cretaceous, so also during the Neocene period, the basin to the north of Mount Shasta appears to have been separated from the Sacramento and Trinity valleys. In the northern basin the Ione deposits form almost a continuous line from Shasta valley northward to Rogue River, or even farther. Regarding their extent eastward, there has been considerable conjecture. They have not yet been definitely traced beyond the summit of the Cascades; but this may be due to their being buried beneath volcanic eruptions. The Ione deposits are evidently those of fresh water, the period being one of extensive lakes lying to the south and east of the Klamath Mountains. In the Rogue River basin, which, as here used, includes the basin of the Klamath Lakes, it has yet to be

proved whether the beds occurring along the western slope of the Cascades should be regarded as the western margin of deposits underlying the Klamath Lakes, or belong to an independent body. It seems almost certain, however, that the basin of the Klamath Lakes must contain similar deposits, and that the Neocene drainage of the same basin was westward, and therefore that there was at least a connection with the deposits of Rogue River valley. Probably the connection was closer than one of mere drainage. But in any case it yet remains to be seen by which channel these waters reached the sea. If the outlet was by the present course of the Klamath, it must have traversed a mountainous country for at least one hundred miles, crossing masses of eruptive rocks like so many barricades, and the present dimensions of the canyon seem hardly proportional to the time and the volume of water that should have been discharged.

On the other hand, an alternative but little less difficult remains in supposing the outlet was through the Rogue River valley. Still, as we have said, the Rogue River valley is a structural depression dating at least from late Cretaceous time; and this fact lends a strong degree of probability for an outlet through this channel. Furthermore, the Cretaceous deposits of the Rogue River valley, as well as the older formations upon which they rest, show a broad line of terracing similar to that described by Mr. Diller in the upper Sacramento valley. This could only have been done in the presence of a body of water in post-Chico times, or by the reducing action of a large stream. It seems most probable, therefore, that the Neocene drainage of the upper Klamath basin was through the Rogue River valley, and that more recently it has been diverted to the present channel of the Klamath.

Overlying the Ione deposits, if there are such in the valley of the Klamath Lakes, are lake deposits apparently of a younger age. Possibly they may represent those of the Lahontan epoch described by Russell.[1] They consist for the most part of white diatomaceous and clayey beds extending far to the south, east,

[1] *Monograph XI, U. S. Geol. Surv.*, p. 143 *et. seq.*

and north of the present limits of the lakes, and aggregating a thickness of two to three hundred feet. They are occasionally, if not generally, interstratified with beds of volcanic sand and ash, and sometimes coarser material, and are often overlain by heavy beds of tuff, and in many cases by lava flows of quite local origin. These diatomaceous beds are accompanied by marginal terraces that plainly mark the former level of the water, probably at its maximum height. These terraces are especially observable in the vicinity of Klamath Falls and along Lost River and elsewhere, though they have been considerably disturbed by faulting and volcanic eruptions.

In the basin of the Trinity River, upon the southern border of the Klamath Mountains, Neocene deposits occur that Mr. Diller no doubt correctly correlates with the Ione of the Sacramento.[1] Here, as in the Rogue River basin, they have nearly a conformable relation to the Cretaceous deposits wherever they are found in contact, and they have not yet been satisfactorily distinguished from each other.

VOLCANIC ACTIVITY.

The Cascade range.—There has been more or less discussion at different times regarding the character and age of the Cascade range. It is now generally conceded to be pre-eminently volcanic in character, but as to its age there is less agreement. There can hardly be any doubt, however, that the Cascade range as a mass of volcanic rocks, is the northward continuation of the volcanic elements of the Sierra Nevada, and that it contains representatives of the lava flows that have covered so much of the Great Basin.

Lavas of the region.—J. E. Spurr has recently summarized some of the facts already known[2] relating to the age and succession of lavas in the Sierra Nevada and the Great Basin. It is apparent that the volcanic activity of this region has extended over long periods of time, beginning at least with the early Tertiary (Eocene) and continuing to the present. It is therefore

[1] *Fourteenth Ann. Rept. U. S. Geol. Surv.*, Pt. II, p. 419.

[2] JOUR. GEOL., Vol. VIII, No. 7, 1900, pp. 621—.

probable that the Cascade range is an accumulation of volcanic materials of as many different epochs. In many places, as near the Klamath River, this succession of periods, as well as the succession of minor flows, is well illustrated. At the head of the Little Shasta River, no less than four epochs are represented by as many different effusions. Dutton recognized the same long duration of volcanic activity in the Cascades of southern Oregon stating that it probably prevailed throughout nearly the whole of the Tertiary.[1]

The Tuscan tuff.—One of the later periods of volcanic activity is represented by what has been called the *Tuscan tuff.* This consists of a series of volcanic fragmental material, sometimes stratified and sometimes without stratification. It has a wide distribution in the upper Sacramento valley, where it has been described and mapped by Mr. Diller.[2] The volcanic tuffs of the Cascades north of Mt. Shasta, as well as the Ione and the Chico, demonstrate the secular accumulation of the lavas forming the range. As a rule the tuffs are interstratified with lava flows of somewhat different characters, some of which are older and some younger than the tuffs. Rhyolitic and andesitic tuffs have a wide distribution to the east of the Cascade Mountains, occurring abundantly in the basin of the Klamath Lakes, where they overlie, for the most part, the diatomaceous deposits as already stated. They also form thick deposits in the region of Silver and Summer lakes.

Faulting of the region.—A large amount of faulting has taken place subsequent to the distribution of these tuffs, often leaving them exposed in conspicuous cliffs. These fault lines, in so far as they occur in the region of the Klamath Mountains, are only outlying members of the great system of faulting traversing northern Nevada and southeastern Oregon, and which have been described by King,[3] Russell,[4] and others.[5]

[1] *Seventh Ann. Rept. Geol. Surv.*, pp. 100–1.

[2] *Eighth Ann. Rept. U. S. Geol. Surv.*, Pt. I, pp. 422–24.

[3] *Fortieth Parallel Repts.*, Vol. I, 1878, p. 735 *et seq.*

[4] *Monograph XI, U. S. Geol. Surv.*, 1885, p. 26 *et seq.*

[5] *Proc. Cal. Acad. Sci.*, 3d ser., Vol. I, p. 262 *et seq.*

Contemporaneous Neocene deposits are now found at all elevations in the Klamath Mountains, up to four thousand feet, and in such relations that it is clear that differential elevation of the region has occurred since their deposition. Probably some of these disturbances were coincident in time with the faulting that has been described as occurring in the Great Basin. In the interior of the Klamath group, faulting on a scale comparable to that of the Great Basin has not yet been clearly recognized, though many minor faults occur that perhaps coincide in time. Sharp flexures, as that along the western border of Scott valley, occur, some of which may be traced for many miles, but there are no well established extensive fault lines.

DEVELOPMENT OF THE PRESENT DRAINAGE.

During middle or late Neocene times there existed among the Klamath Mountains and along their southern and eastern borders extensive series or systems of lakes that have left their deposits in unmistakable evidence. These deposits rest conformably upon those of later Cretaceous, in such a manner that they have not always been distinguished.

During the period which intervened between the deposition of these two series of strata—the Eocene—we are left to infer that there was unrestrained erosion and aereal reduction throughout the region, covering indeed the long interval between the close of the Chico and the opening of the Ione, to the effects of which those of the Ione itself were added. Whatever traces there may be, therefore, of an ancient peneplain in the Klamath Mountains, it must doubtless be in part referred to this time. The fact should be emphasized that the drainage of the Klamath Mountains is westward, and it has probably remained so since Cretaceous time. There is no drainage that can properly be called eastward from these mountains, while the streams leading to the west derive their waters even from the eastern limits of the group, and probably during the Neocene period it was much the same. The canyons, or river channels of the period had been developed approximately to their present length and are fairly

represented in those of the present, except as to depth. The canyon of the Klamath had retreated nearly to the drainage of the Klamath Lakes, and was possibly separated from it by only a low divide. As to the causes which led the drainage of the Klamath Lakes from Rogue River to the present outlet, it is not quite clear whether it was by the choking of the Rogue River outlet by later lavas, or by faulting, or by both combined. To the north of the Klamath River there is evidence of considerable faulting along the western slope of the Cascades, the upthrow of which could have cut off the outlet from the lakes in the direction of Rogue River, while in the vicinity of the Klamath no great amount of faulting has been observed, but on the contrary there is a depression of the Ione and Tuscan deposits. Furthermore, the Klamath River cuts these deposits in such a manner as to harmonize with this view.

SUMMARY AND CONCLUSIONS.

The physiographic features of the Klamath Mountains are in general those of crossing ranges and intervening structural valleys, modified to a considerable extent by the effects of ordinary river erosion. Evidences of an elevated peneplain are unmistakable at an altitude of four or five thousand feet above sea level. This peneplain is to be referred in part to degradation during the Cretaceous period, and in part to such action during the Tertiary. This peneplain has been subjected to disturbances ranging in time from inter-Cretaceous to the present. The earlier differential movements were those which originated the structural features that are conspicuous at present. The later movements have developed folds with north and south axes, the evidences of which are many. The principal north and south fold coincides with the Salmon River range, seen to the west of Scott valley, and its continuation on the north and south toward the Rogue River Mountains and the Trinity basin. It crosses all of the principal rivers of the region in a manner that demonstrates its secondary age, which was probably in part comparatively recent. The streams have maintained their westward

course across this fold developing in nearly every case deep and narrow canyons, and proving its gradual elevation. The result of this action is a type of valley peculiar to this region, namely, that of valleys entirely inclosed by mountains and drained through deep narrow canyons. The larger basins of the Klamath Mountains include the Rogue River basin and that of the Trinity River. Both contain upper Cretaceous and Neocene deposits, almost or quite conformable, overlain by beds of volcanic tuff or lavas. During both of these periods the valley of the Klamath Lakes was connected with the Rogue River drainage, which condition extended into the latest Tertiary times.

The lake systems of the Neocene were two, that of the upper Rogue River (Klamath) basin, and that of the Trinity basin. Throughout the Tertiary, volcanic eruptions were in progress, and following this period occurred some of the later flows of lava and the formation of beds of volcanic tuff throughout the Cascade range and eastward. The latest flows accompanied by more or less faulting diverted the drainage of the Klamath Lakes from the Rogue River to the Klamath, and accompanying movements in a similar manner disturbed the drainage in other portions of the Klamath Mountains.

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